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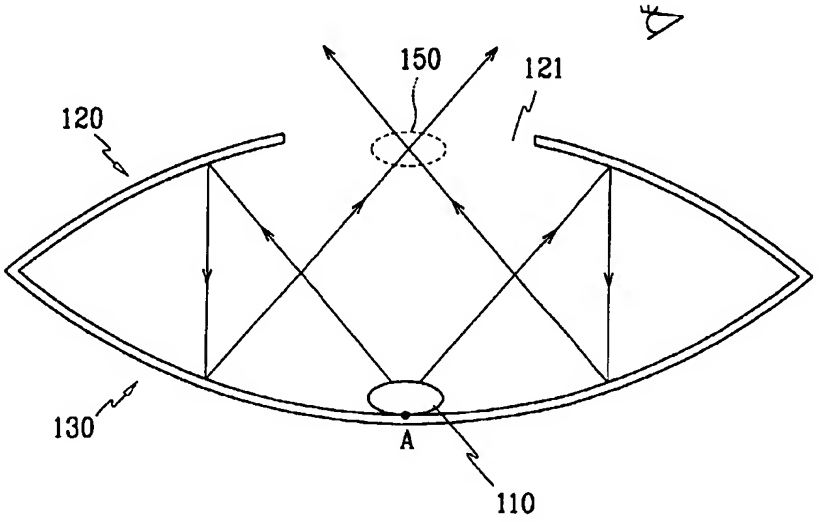
(54) Title: THREE-DIMENSIONAL IMAGE DISPLAY APPARATUS USING ASPHERICAL MIRRORS



(57) Abstract: A three- dimensional image display apparatus using two aspherical (paraboloidal) mirrors for forming a three-dimensional image of an object is disclosed. The apparatus has two paraboloidal mirrors which face each other, and the optical axes of the mirrors are coincident with each other. The vertex of the second paraboloidal mirror is coincident with a focal point of the first paraboloidal mirror, and the object is placed around the vertex of the second paraboloidal mirror so that the real image of the object is viewed through the opening of the first paraboloidal mirror. When the focal length of the first paraboloidal mirror is the same as that of the second paraboloidal mirror, the real image is formed around the vertax of the first mirror. When a focal length of the mirror is shorter that of the second mirror, the real image of the object is formed farther than the vertex of the first paraboloidal mirror.

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THREE-DIMENSIONAL IMAGE DISPLAY APPARATUS USING ASPHERICAL MIRRORS

BACKGROUND OF THE INVENTION

(a) Field of the Invention

The present invention relates to a three-dimensional image display apparatus, and more particularly, to such an apparatus which displays a real image of an object using aspherical mirrors, specifically paraboloidal mirrors.

Further, the present invention allows a user to view the three-dimensional image in various viewing angles so that it is applicable to various applications including light fixtures, decoration articles, electronic and electrical products for home or office, various optical instruments, as well as scientific articles and playthings.

(b) Description of the Related Art

Recently, three-dimensional display apparatuses have been developed, in which a real image of an object is formed so that a user may view the image with a three-dimensional effect as if it were a real object. However, the conventional three-dimensional display apparatuses display images which are placed in a vertical direction to the object using a beamsplitter, so that it is difficult to reduce the size of the apparatus. Therefore, it is not suitable to embed the apparatus in a small article such as scientific articles or playthings.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a three-dimensional display apparatus using aspherical mirrors including paraboloidal mirrors, adaptable to various articles such as scientific articles, playthings, light fixtures, decorating articles, electronic and electrical products for home or office, and various optical instruments.

It is another object to provide a three-dimensional display apparatus having various displaying effects, by rotating an object and/or the apparatus itself.

It is still another object to provide a three-dimensional display apparatus having various displaying effects, by inserting a light-emitting device into an object or using an illuminating device.

To achieve these objects, as embodied and broadly described herein, a three-dimensional image display apparatus according to the invention comprises a first paraboloidal mirror having an opening formed at a vertex thereof and a second paraboloidal mirror disposed facing the first paraboloidal mirror, an optical axis of the second paraboloidal mirror being coincident with that of the first paraboloidal mirror. The vertex of the second paraboloidal mirror is coincident with a focal point of the first paraboloidal mirror, and the object is placed around the vertex of the second paraboloidal mirror, so that the real image of the object is viewed through the opening of

the first paraboloidal mirror.

When the focal length of the first paraboloidal mirror is the same as that of the second paraboloidal mirror, the real image is formed around the vertex of the first mirror. When a focal length of the first mirror is shorter that that of the second mirror, the real image of the object is formed farther than the vertex of the first paraboloidal mirror.

The second paraboloidal mirror preferably has an opening formed at a vertex thereof, and the apparatus further has a support, disposed behind the opening of the second paraboloidal mirror, for supporting the object, so that the object may be placed around the vertex of the second paraboloidal mirror. One or more rotating units are preferably constructed to rotate the object and/or the mirrors.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings provide a further understanding of the invention, and together with the Detailed Description, explain the principles of the invention. In the drawings:

Figs. 1-2 show a three-dimensional image display apparatus according to a first preferred embodiment of the present invention;

Fig. 3 illustrates the characteristics of a paraboloidal mirror;

Fig. 4 illustrates optical principles of the present invention;

Fig. 5 shows a three-dimensional image display apparatus according

to a second preferred embodiment of the present invention;

Fig. 6 shows the three-dimensional image display apparatus of Fig. 5 when an object is an imaging screen;

Fig. 7 shows a three-dimensional image display apparatus according to a third preferred embodiment of the present invention; and

Figs. 8-10 show a three-dimensional image display apparatus according to a fourth preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described in detail with reference to the accompanying drawings. The same reference numerals indicate the same elements herein.

Referring to Figs. 1-2, a three-dimensional image display apparatus according to a first preferred embodiment will be described. As shown in Fig. 1, the three-dimensional image display apparatus has a first paraboloidal mirror 120 in an upper position and a second paraboloidal mirror 130 in a lower position. The mirrors 120, 130 are disposed facing each other and the optical axes thereof are coincident with each other. A vertex A of the second paraboloidal mirror 130 is positioned at a focal point of the first paraboloidal mirror 120. An object to be displayed is placed around the vertex A of the second paraboloidal mirror 130, in the lower position.

The first paraboloidal mirror 120 has an opening which is formed at a

vertex of the first paraboloidal mirror 120, so that a user can see a real image 150 of the object, which is formed by the first and second paraboloidal mirrors 120, 130.

The operation of the first preferred embodiment of the present invention is as follows.

Referring to Fig. 3, the characteristics of a paraboloidal mirror will be described. When rays enter into the paraboloidal mirror in parallel to an optical axis O of the mirror, they are reflected and then all brought to a focal point F of the mirror. Rays emitted from the focal point F are reflected and then propagate in parallel to the optical axis O of the mirror.

The three-dimensional display apparatus of the present invention uses this principle of the paraboloidal mirror. A three-dimensional image is formed by two paraboloidal mirrors disposed facing each other such that the focal point F1 of the first paraboloidal mirror 120 is coincident with the position of the vertex A of the second paraboloidal mirror 130.

Referring to Fig. 4, two paraboloidal mirrors are used to form a real image of the object. Let us assume that a point source of light lies on the focal point F1 of the first paraboloidal mirror. A ray R1 emitted from the point source is reflected from the first paraboloidal mirror 120 to be a ray R2 that is parallel to the optical axis O. The ray R2 is then reflected from the second paraboloidal mirror 130 through a focal point F2 of the second paraboloidal

mirror 130 to be a ray R3. Therefore, the real image of the object is formed around the focal point F2 of the second mirror 130 when the object is laid on either the focal point F1 of the first paraboloidal mirror 120 or the vertex A of the second paraboloidal mirror 130.

When a focal length of the first mirror 120 is the same as that of the second mirror 130, the real image 150 of the object is formed at the vertex of the first paraboloidal mirror 120. When a focal length of the first mirror 120 is shorter that that of the second mirror 130, the real image 150 of the object is formed farther than the vertex of the first paraboloidal mirror 120. That is, the real image 150 is formed away from the vertex of the first mirror 120 towards a user. When a focal length of the first mirror 120 is longer than that of the second mirror 130, the real image 150 of the object is formed nearer than the vertex of the first paraboloidal mirror 120 within the two mirrors 120, 130. Therefore, it is possible to determine a desirable image position by selecting the focal lengths of the two mirrors. The user may view the real image 150 at an oblique angle such as 45° with respect to the optical axis O.

Fig. 1 shows the apparatus in the case that the focal length of the first mirror 120 is the same as that of the second mirror 130, while Fig. 2 shows the apparatus in the case that the focal length of the first mirror 120 is shorter than that of the second mirror 130.

Referring now to Fig. 5, a second preferred embodiment of the present invention will be described. A three-dimensional display apparatus of Fig. 5 is similar to the apparatus of Fig. 1 according to the first preferred embodiment, but the apparatus of Fig. 5 has a second paraboloidal mirror 140 having an opening 131 around the vertex of the second mirror 140. The object 110 is laid on a support 140 through the opening 131. The support 140 is placed behind the second mirror 130. That is, the three-dimensional image display apparatus according to the second preferred embodiment has a first paraboloidal mirror 120 in an upper position and a second paraboloidal mirror 130 in a lower position. The first and second paraboloidal mirrors 120, 130 have openings 121, 131 at their vertexes, respectively. The mirrors 120, 130 are disposed facing each other and with coincident optical axes. The apparatus has a support 140 placed behind the opening 131 of the second mirror 130 for supporting the object.

A vertex A of the second paraboloidal mirror 130 is positioned at a focal point of the first paraboloidal mirror 120, similar to the first preferred embodiment. The object is laid on the support 140 through the opening 131.

The operation of the second preferred embodiment is similar to the first preferred embodiment except for the support 140 on which the object is laid. When the object is a light bulb, the apparatus is applicable to illumination devices such as floor lamps.

Fig. 6 illustrates the object which is an imaging screen such as a liquid crystal device (LCD) monitor. The object is a plane of a two-dimensional article, so that the image 151 becomes a two-dimensional plane.

Referring now to Fig. 7, a third preferred embodiment of the present invention will be described. A three-dimensional display apparatus of Fig. 7 is similar to the apparatus of Fig. 5 according to the second preferred embodiment. Further, the apparatus of Fig. 7 has one or more lamps 160 inside the support. In the third preferred embodiment, the lamps 160 are mounted inside the support 140. A translucent shading sheet 161 is placed between the lamp 160 and the object and prevents the lamps 160 from being formed into an image. The lamps 160 are preferably used in the case that the object is not light-emitting itself.

When the object 110 cannot emit light itself, a light emitting device such as a light bulb or a light emitting diode is mounted under the object 110 on the support 140 and then fits into the object, thereby facilitating clear viewing.

The object 110, the light-emitting device, or the auxiliary lamp 160, if any, may be adjusted to be brighter or darker so that the image 160 also becomes brighter or darker, resulting in various displaying effects. Further, sound facilities (not shown) may be used in the apparatus. For example, suitable sound effects from the sound facilities may be used in accordance

with variations of the brightness of the image, resulting in maximization of the displaying effects.

Referring next to Figs. 8-10, a fourth preferred embodiment of the present invention will be described. A three-dimensional display apparatus according to the fourth preferred embodiment has rotating members which may rotate the object and/or the first and second paraboloidal mirrors, thereby obtaining various displaying effects.

First, the apparatus as shown in Fig. 8 is similar to the apparatus of Fig. 5 according to the second preferred embodiment, and it further has a rotating member 170 to rotate the object 110. The real image 150 is also rotated in accordance with the rotation of the object. The rotating member 170 has a driving motor 171 mounted inside the support 140, with a turntable 172 connected to the driving motor 171. The object 110 is disposed on the turntable 172 and is then rotated according to the driving motor 171, thereby rotating the real image 150.

A three-dimensional display apparatus as shown in Fig. 9 uses a rotating member 170 to rotate both the object and the two mirrors 120, 130, resulting in displaying effects in which the mirrors as well as the object are rotated. The rotating member 170 has a driving motor 171 mounted inside the support 140, and a turntable 172 connected to the driving motor 171. The two mirrors 120, 130 as well as the object 110 are disposed on the

turntable 172 and then rotated according to the driving motor 171, thereby rotating the real image 150 and the entire mirrors 120, 130. In this embodiment, the external appearance of the two mirrors 120, 130 may be designed as a flying saucer and the like, making the best use of their own shape, so that the apparatus provides users with displaying effects of the flying saucer as well as the rotation.

Referring now to Fig. 10, a three-dimensional display apparatus uses a rotating member 170 to rotate the two mirrors 120, 130 only, resulting in displaying effects that the mirrors are rotated while the real image 150 is stationary. The rotating member 170 has a driving motor 171 mounted inside the support 140, a driving gear 175 connected to the driving motor 171, a turntable 172, a dependent gear 177 connected to the turntable 172, and a prop 177 on which the object lies. When the driving motor 171 is operated, the object 110 remains stationary on the prop 177 while the mirrors 120, 130 on the turntable 172 are rotated through the dependent gear 177 and the driving gear 175 by the driving motor 171.

In this case, when the outside of the two mirrors 120, 130 is designed as a flying saucer, it provides users with displaying effects of the flying saucer rotating and the real image 150 remaining stationary.

The apparatus according to the fourth preferred embodiment may have auxiliary light devices such as lamps, light-emitting diodes, and sound

facilities to maximize the displaying effects, as described in the third preferred embodiment.

It will be apparent to those skilled in the art that various modifications and variations can be made to the apparatus of the present invention without departing from the spirit and scope of the invention. The present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

A three-dimensional display apparatus according to the present invention displays a real image which causes the illusion that a real object exists in space by using two aspherical mirrors. The real object mounted inside the apparatus provides a real image viewed from the outside.

Using the present invention, a three-dimensional real image is viewed with various displaying effects, so that the apparatus may be adaptable to various intricate articles such as scientific articles, playthings, light fixtures, decoration articles, electronic and electrical products for home or office, and various optical instruments. Further, the appearance of the apparatus may be designed as a flying saucer shape, thereby facilitating application to various fancy articles.

The image display unit according to the present invention has various three-dimensional effects such as rotating effects of the image and/or the apparatus itself, lighting effects, and sound effects.

WHAT IS CLAIMED IS:

1. A three-dimensional image display apparatus for forming a three-dimensional image of an object, comprising:

a first paraboloidal mirror having an opening formed at a vertex thereof; and

a second paraboloidal mirror disposed facing the first paraboloidal mirror, an optical axis of the second paraboloidal mirror being coincident with that of the first paraboloidal mirror,

wherein a vertex of the second paraboloidal mirror is coincident with a focal point of the first paraboloidal mirror, and the object is placed around the vertex of the second paraboloidal mirror.

2. A three-dimensional display apparatus as recited in claim 1, wherein the second paraboloidal mirror has an opening formed at a vertex thereof, and the apparatus further comprises a support placed behind the opening of the second paraboloidal mirror for supporting the object, so that the object is placed around the vertex of the second paraboloidal mirror.

3. A three-dimensional display apparatus as recited in claim 2, further comprising:

a first rotating unit, connected to the second paraboloidal mirror, for rotating both the first and second paraboloidal mirrors.

4. A three-dimensional display apparatus as recited in claim 2 or 3,

further comprising:

a second rotating unit, connected to the object, for rotating the object.

5. A three-dimensional display apparatus as recited in claim 1, wherein a focal length of the first paraboloidal mirror is the same as that of the second paraboloidal mirror.

6. A three-dimensional display apparatus as recited in claim 1, wherein a focal length of the first paraboloidal mirror is shorter than that of the second paraboloidal mirror.

7. A three-dimensional display apparatus as recited in claim 1, further comprising sound facilities for producing sound effects.

8. The three-dimensional image display apparatus as recited in claim 2, wherein the image display unit further comprises:

a lamp, placed inside the support, for illuminating the object; and

a shading sheet, placed between the lamp and the object, for shading the lamp to prevent the mirrors from forming an image of the lamp.

9. The three-dimensional image display apparatus as recited in claim 2, further comprising:

a light-emitting device, placed under the object, so that the light-emitting device fits into the object.

10. The three-dimensional image display apparatus as recited in claim 8 or claim 9, wherein the brightness of the lamp or the light-emitting

device is adjustable.

11. The three-dimensional image display apparatus as recited in claim 1, 2, 3, 5, 6, 7, 8, or 9, wherein the apparatus is formed with a specific article, the specific articling being a scientific article, a plaything, a light fixture, a decoration article, an electronic or electrical product for home or office, or an optical instrument.

AMENDED CLAIMS

[received by the International Bureau on 28 May 2002 (28.05.02);
original claims 4-11 amended; new claims 12 and-13 added;
remaining claims unchanged (3 pages)]

WHAT IS CLAIMED IS :

1. A three-dimensional image display apparatus for forming a three-dimensional image of an object, comprising:

a first paraboloidal mirror having an opening formed at a vertex thereof; and

a second paraboloidal mirror disposed facing the first paraboloidal mirror, an optical axis of the second paraboloidal mirror being coincident with that of the first paraboloidal mirror,

wherein a vertex of the second paraboloidal mirror is coincident with a focal point of the first paraboloidal mirror, and the object is placed around the vertex of the second paraboloidal mirror.

2. A three-dimensional display apparatus as recited in claim 1, wherein the second paraboloidal mirror has an opening formed at a vertex thereof, and the apparatus further comprises a support placed behind the opening of the second paraboloidal mirror for supporting the object, so that the object is placed around the vertex of the second paraboloidal mirror.

3. A three-dimensional display apparatus as recited in claim 2, further comprising:

a first rotating unit, connected to the second paraboloidal mirror, for rotating both the first and second paraboloidal mirrors.

4. (amended) A three-dimensional display apparatus as recited in claim 2, further comprising:

a second rotating unit , connected to the object, for rotating the object.

5. (amended) A three-dimensional display apparatus as recited in claim 1, further comprising:

a rotating unit , connected to the object, for rotating the object.

6. (amended) A three-dimensional display apparatus as recited in claim 1, wherein a focal length of the first paraboloidal mirror is the same as that of the second paraboloidal mirror.

7. (amended) A three-dimensional display apparatus as recited in claim 1, wherein a focal length of the first paraboloidal mirror is shorter than that of the second paraboloidal mirror.

8. (amended) A three-dimensional display apparatus as recited in claim 1, further comprising:

sound facilities for producing sound effects.

9. (amended) The three-dimensional image display apparatus as recited in claim 2, wherein the image display unit further comprises

a lamp, placed inside the support, for illuminating the object; and

a shading sheet, placed between the lamp and the object, for shading the lamp to prevent the mirrors from forming an image of the lamp.

10. (amended) The three-dimensional image display apparatus as recited in claim 2, further comprising:

a light-emitting device, placed under the object so that the light-emitting device fits into the object.

11. (amended) The three-dimensional image display apparatus as recited in claim 9, wherein the brightness of the lamp is adjustable.

12. (amended) The three-dimensional image display apparatus as recited in claim 10, wherein the brightness of the light-emitting device is adjustable.

13. (amended) The three-dimensional image display apparatus as recited in claim 1, wherein the apparatus is formed with a specific article, the specific articling being a scientific article, a plaything, a light fixture, a decoration article, an electronic or electrical product for home or office, or optical instrument

FIG.1

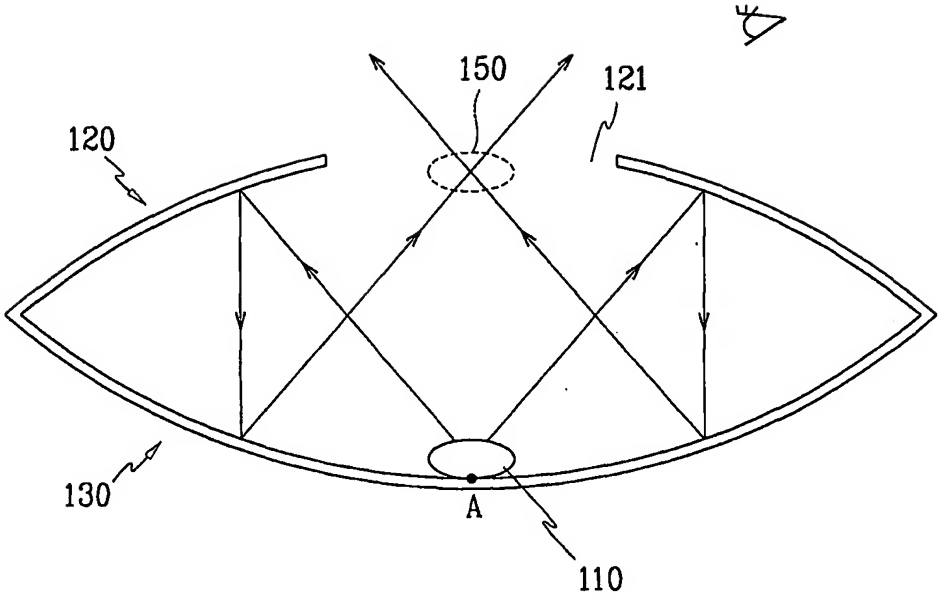


FIG.2

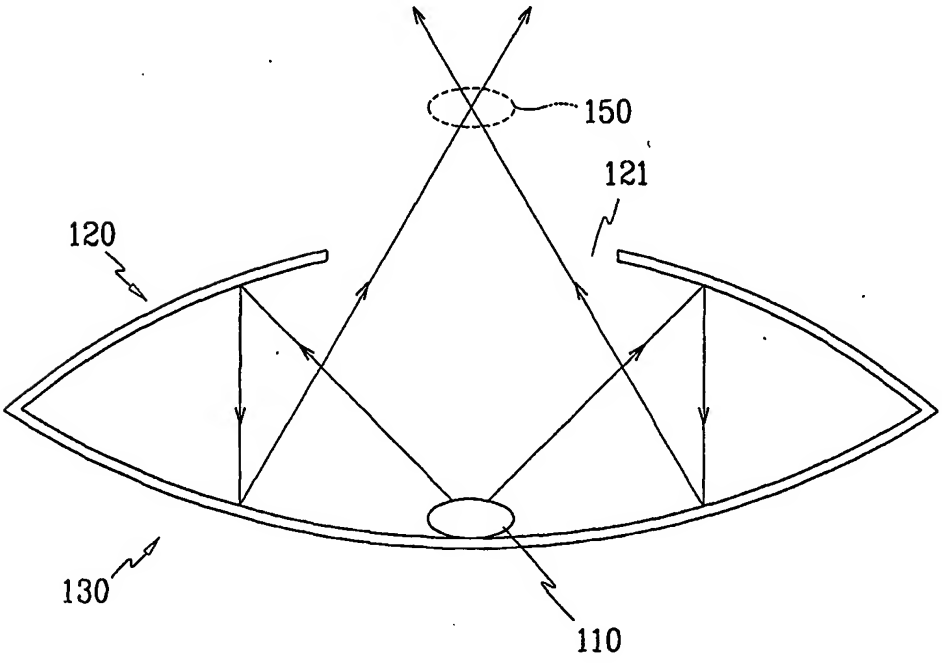


FIG.3

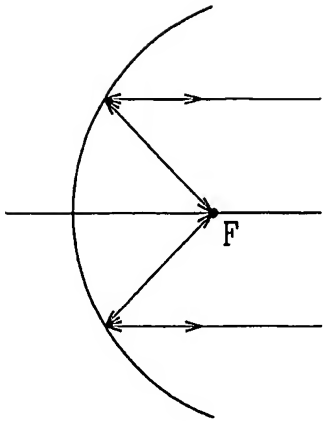


FIG.4

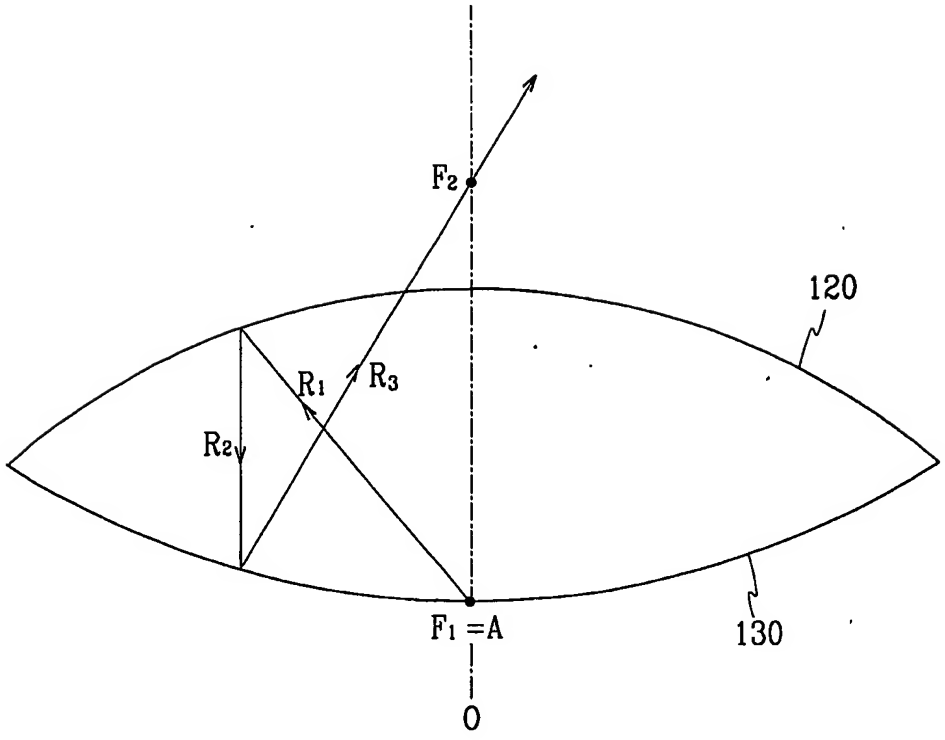


FIG.5

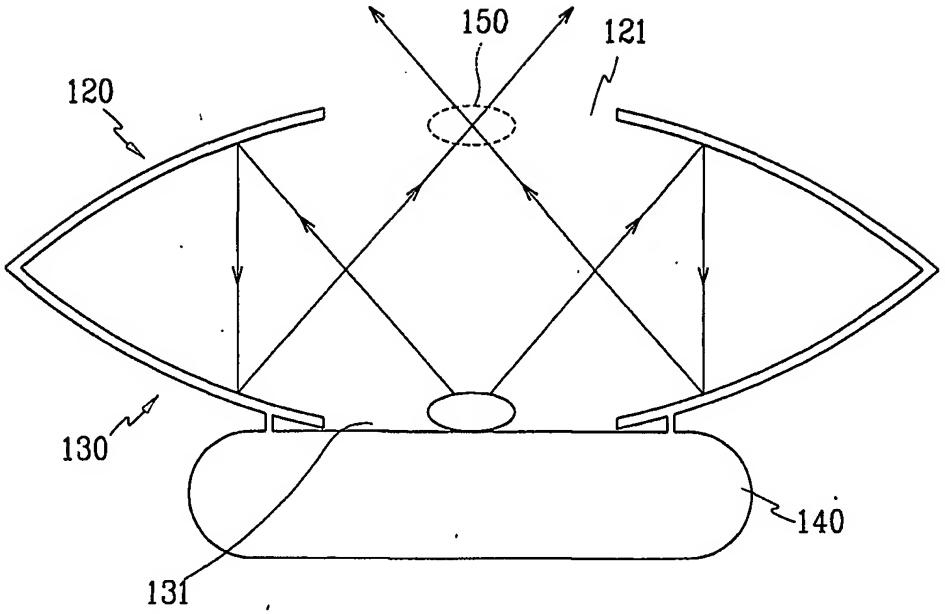
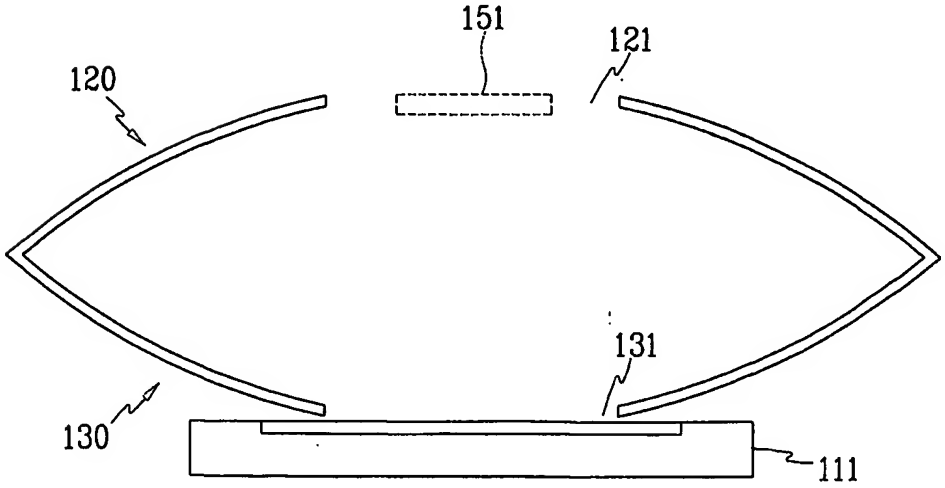


FIG.6



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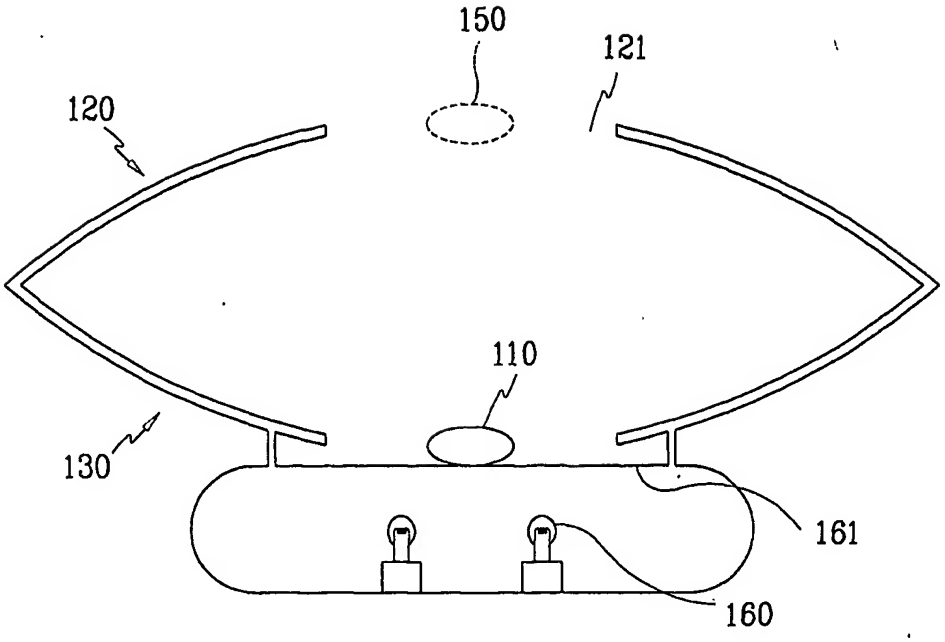
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FIG.8

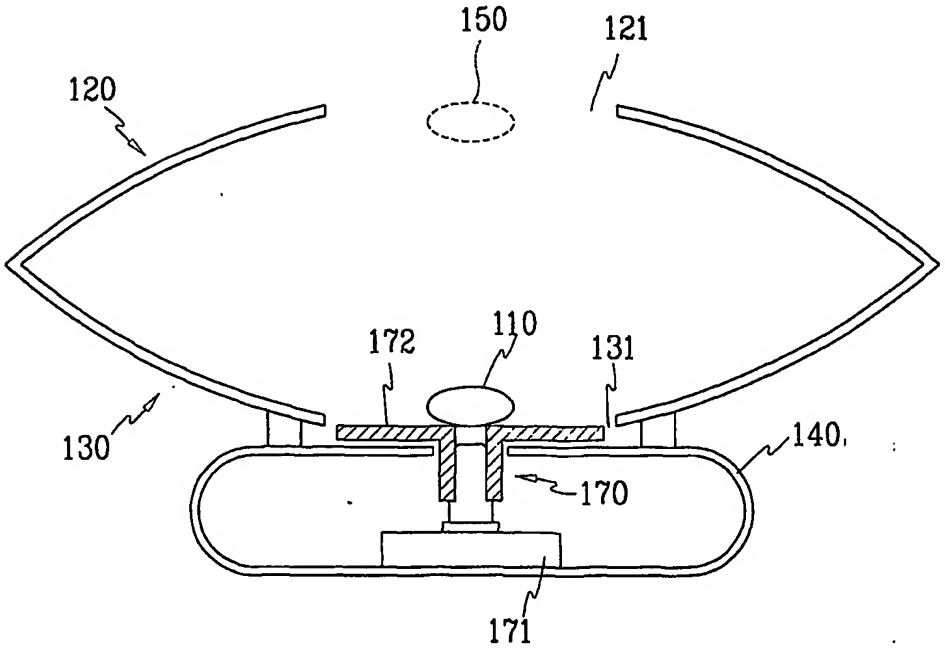
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FIG.9

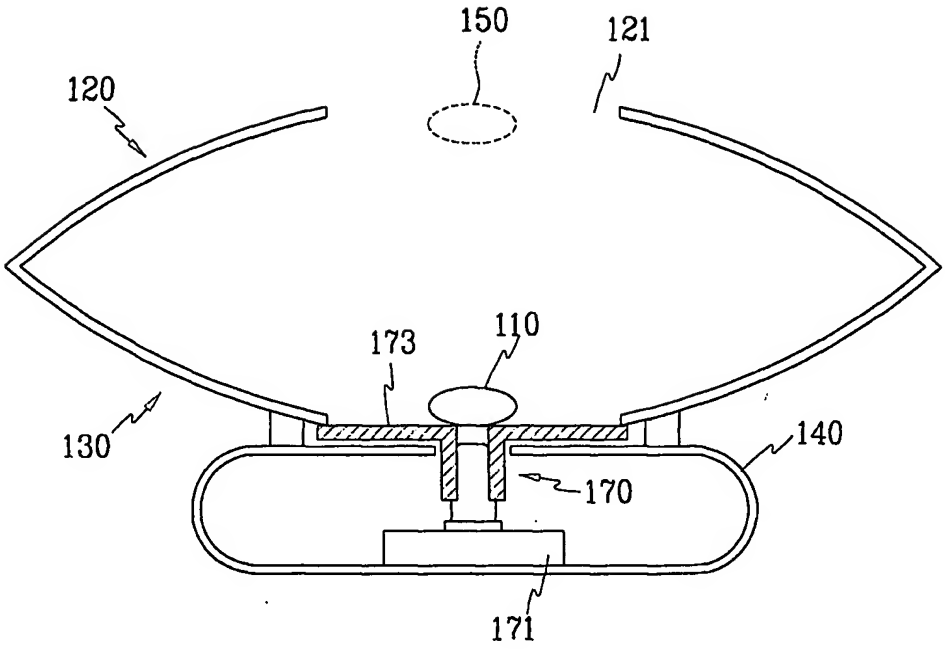
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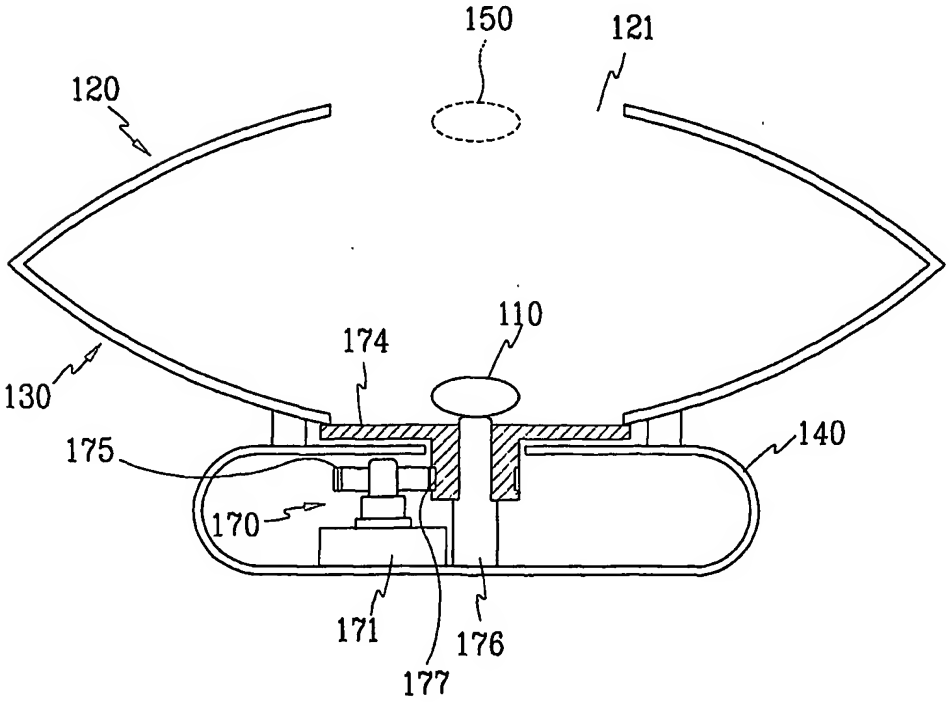
FIG.10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INTERNATIONAL SEARCH REPORT

ernational application No.
PCT/KR02/00130

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 G02B 27/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC7 G02B 27/22; G02B 17/06

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NPS, "focal", "mirror", "real", "image", "projection"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4802750 A1 (Grand Mirage) 7 February 1989 See the whole document	1, 2, 5-7

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
25 MARCH 2002 (25.03.2002)	26 MARCH 2002 (26.03.2002)

Name and mailing address of the ISA/KR	Authorized officer
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